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Alice Milivinti

How many Migrants does the Swiss Pension System Need?

Working Paper #19
November, 2018

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Alice Milivinti
(University of Geneva)

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nccr – on the move, University of Neuchatel, Rue Abram-Louis-Breguet 2, 2000 Neuchâtel, Switzerland
Contact for the Working Paper Series: info@nccr-onthemove.ch

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Abstract

The positive role exerted by migrants to decelerate the ageing population process of developed countries has been stressed by many studies. However, the actual number of migrants needed to sustain the pension systems and its effectiveness in the long-run often remains tacit. While assuming the increment of the retired population to be the only shock, this study undertakes an accounting exercise of the Swiss public pension scheme. A ceteris-paribus analysis articulates the alternative compensatory actions, such as the increase in public expenditure, workforce through migration, retirement age, GDP and productivity, required to face the aggravating situation of the first pillar of the Swiss pension system (AHV/AVS) between 2014 and 2045. By taking advantage of the federal structure of Switzerland, the repercussions of specific compensatory actions adopted at the national level are evaluated for each canton. In general, even though a policy mix is the most desirable, immigration could by no means be a self-sufficient solution. In fact, if immigration would be the only compensatory action to maintain the AHV/AVS at its 2014 level, the Swiss foreign population should increase, by 2045, of an extra 110% after having controlled for evolution of migration flows and stocks.

Keywords

International Migration; Pension System.

Acknowledgments

I would like to thank Prof. Philippe Wanner, Prof. Tobias Müller, Prof. Jean-Michel Bonvin, Dr Marco Pecoraro and Dr Thomas Spoorenberg for their comments.

Contacts

alice.milivinti@unine.ch

Institute for Demography and Socioeconomics (IDESO), Geneva School of Social Sciences University of Geneva, 40, Bd du Pont d'Arve, 1211 Genève 4.

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Introduction

One of the most popular debated remedies to face the rise of an ageing population is immigration (see among others Sinn (1997); Razin and Sadka (1998); Han (2013)). The support of fresh workforce is claimed to bear the burden of a pension system collapsing under the pressure of longer life expectancies, lower fertility rates and the forthcoming retirement of the baby boomers. Migrants can benefit the age structure of the population by increasing the share of labour force and by supporting the dependency ratio. Nevertheless, some studies have already pointed out how immigration might not be a panacea for solving the problems of the weakening pension systems (Munz and Werding, 2005; Serrano, Eguía, and Ferreiro, 2011; UN Population Devision, 2000). In fact, the inflow of foreign workforce is just one among others solutions and not necessary the easiest one, also due to the social costs it brings, such as integration. The current research, while giving particular relevance to study the role of immigration, tries to shed light on alternative compensatory actions available to policy makers to prevent the possible collapse of the Swiss retirement system. Among the three pillars constituting the Swiss pension system, where the 1^{st} is the federal pension scheme, the 2^{nd} is the pension funds run by investment foundations, voluntary joint by employers, and the 3^{rd} includes private investments, I exclusively focus on the 1^{st} pillar (Alters- und Hinterlassenenversicherung (AHV) in German, Assurance vieillesse et survivants (AVS) in French and Assicurazione vecchiaia, superstiti e invalidità (AVS) in Italian), which is a pay-as-you-go system (PAYG)[1] subscribed by all people working and/or living in Switzerland.

Switzerland was born as a Confederation of cantons under the principle to give to the federal state the minimum of powers necessary to survive as a union. Throughout history Switzerland became a federal semi-direct democratic state, with a large decentralization across its administrative units, the cantons. In addition to their powers cantons encase cultural, linguistic and religious, differences which reflect historical stratifications. Such regional peculiarities are mirrored in many areas of the political debate and they can create internal tensions when they generate contrasting positions over topics decided at the federal level. Given that one of the few federal responsibilities is the AHV/AVS, it is interesting to shift the prospective of the analysis to a cantonal level. Such approach will display a cantonal AHV/AVS balance just in the prospective of evaluating how alternative central actions could differently affect each canton. In fact, to outline the different demographic issues each canton is facing will be important to take equitable federal decisions.

Starting from the model of Gil-Alonso (2012), the current study investigates the evolution of the Swiss pension system, between 2014-2045, for the 26 cantons. A *ceteris paribus* analysis, where changes are considered one at time, is developed in order to understand which policies would keep the balance as in the base year 2014. After having produced specific immigration and population forecasts (Milivinti and Benini, 2017), the deficit in workforce results to be unbridgeable if either immigration, the augmentation of the retirement age or the rise of the employment rate are considered separately. Feasible alternatives require a mix of them combined with an increase of the public expenditure, at the expenses of a larger public deficit, and the achievement of a target GDP growth.

The paper is mainly organised in two parts. The first photographs the Swiss demographic situation, looking closely at the foreign population and it produces migration and population forecasts. The second part, built on the first, introduces the model used to describe the pension system and to develop the *ceteris paribus* analysis, investigating how cantons might be differently affected by alternative measures.

[1] In a PAYG system the employed people pay the pension benefits of the retired.

Data

This study takes advantage of a newly released dataset, which has the merit of having linked, for the first time, a collection of administrative records and surveys stemming from the Swiss Federal Statistical Office (SFSO) and the Secretariat for Migration (SEM) (Steiner and Wanner, 2015)[2]. The data harmonization is based on the linkage between the register of foreigners (ZAR 1998-2010) and the matched population registers (STATPOP 2010-2016). The explanatory potential of these data, which mainly contain demographic information, has been enriched by the contribution of other databases: the old age and survivors' insurance (AHV/AVS 1998-2014) contributions (Register of Individual Accounts (CI)) and benefits (Annuities Register (RR)), the unemployment insurance payments (ASAL/PLASTA 1998-2014) and structural surveys (SE/RS 2010-2014). In addition, other data source employed by this investigation are the Swiss Labour Force Survey, ESPOP, Swiss Federal Statistical Office (SFSO) population forecasts (Swiss Federal Statistical Office, 2015b) and the SFSO cross-border workers statistics (Swiss Federal Statistical Office, 2017). Finally, for the implementation of the second part of the research, the *ceteris paribus* analysis, the study also relies on the OECD long-term projections of public pension expenditure (OECD, 2015) and the OECD regional economic statistics (OECD, 2017).
The reliance on the Swiss data released by the SFSO conditions the definition of foreign population and immigration that it is used in the rest of the article. I refer to foreign population as people of non-Swiss nationality residing in Switzerland, which would also include people born in Switzerland form non-Swiss parents who have not been naturalized. Instead, I indicate as "immigrants", people of non-Swiss nationality entering Switzerland. In other words, the foreign population is migration stocks and immigrants and migration flows.

Summary Statistics

Foreign population in Switzerland has mainly experienced a positive trend both in absolute and in relative terms in the past 45 years, see Figure 1-2. Its minimum share of was reached in 1979 when it amounted to 14.35% of the total population and the maximum in 2016 with almost 25%. Due to their age structure (Figure 4) foreigners not only contribute to the overall increase of the Swiss population, but also to the workforce (Figure 2) helping to support the old dependency ratio (Figure 3). In fact, despite the increase in the average foreigners' age (Figure 5), the natives' population remains older. The observed rise in the mean age is also due to the fact that recent migration flows are more educated than the old ones. Figure 6 represents the share of foreigners by skill level with respect to the total population. A sharp acceleration in the share of highly skilled migrants has been observed since the mid-90s, which made such category larger than the middle skilled migrants in 1998 and than the low skilled migrants in 2004.
A closer look to the cantonal level shows no significance relation between cantonal rates of foreigners and mean age. For example, Figure 7 depicts a non significant negative linear relation observed between the share of resident foreign population (permanent and non permanent) and the average age in each canton in the year 2014. Considering their proportion of foreigners, Geneva (GE) and Basel-Stadt (BS) are the two cantons with the highest average age with respect to the share of foreigners, which might suggest the presence of a skilled foreign population

[2]The data have been elaborated by the project "Mapping the Demographics of the New Forms of Mobility and Measuring their Socio-economic Impact" within the National Center of Competence in Research nccr - on the move financed by the Swiss National Science Foundation.

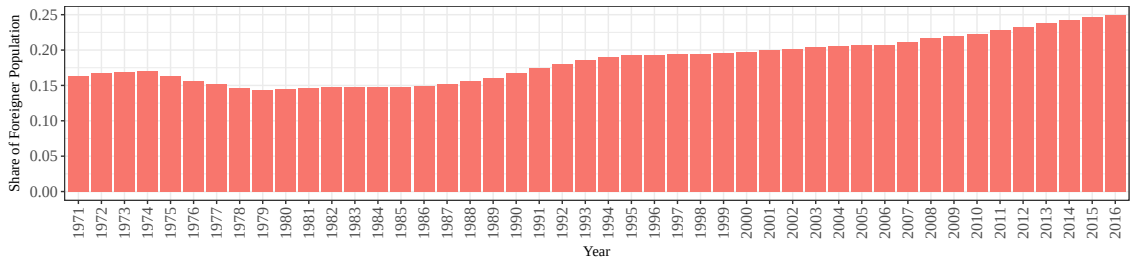

Figure1: Share of migrant population from 1971 to 2016. Sources: ESPOP and STATPOP.

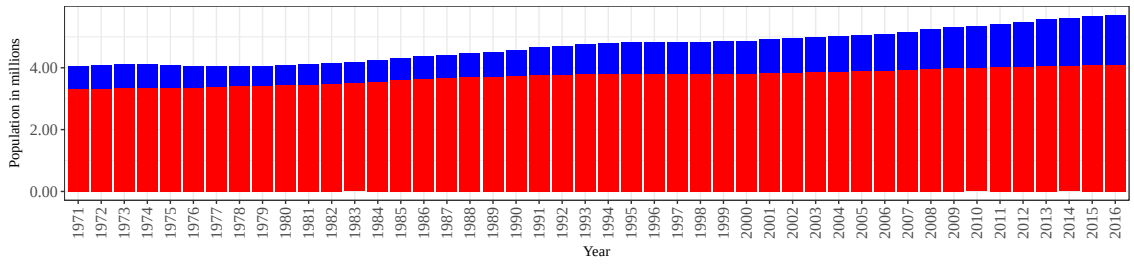

Figure2: Population between 15 and 65 years old from 1971 to 2016 by nationality. The Swiss Population is in red while the foreigner in blue. Sources: ESPOP and STATPOP.

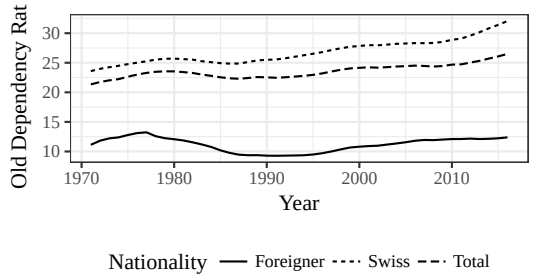

Figure3: Dynamics of the old dependency ratio for natives (dotted line), foreigners (bold line) and the total (dashed line). Sources: ZAR and STATPOP.

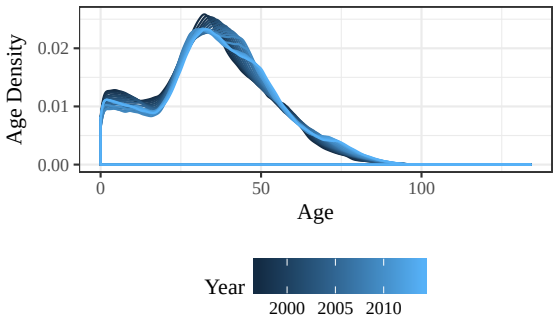

Figure4: Foreigners' age distribution from 1998 to 2014. Sources: ESPOP and STATPOP.

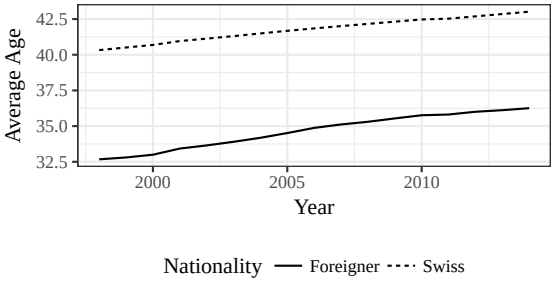

Figure5: Evolution from 1998 to 2014 of the population average age for natives (dotted line) and foreigners (bold line). Sources: SE/RS, ZAR, STATPOP.

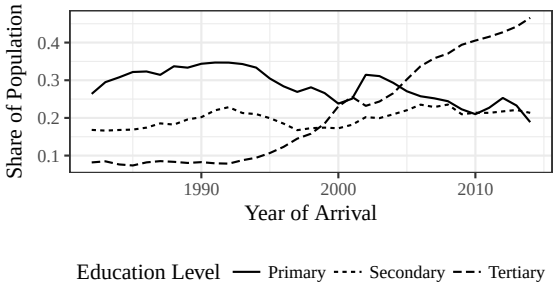

Figure6: Foreign workforce composition (15-65 years old) by education levels between 1995 and 2014. Source: SE/RS.

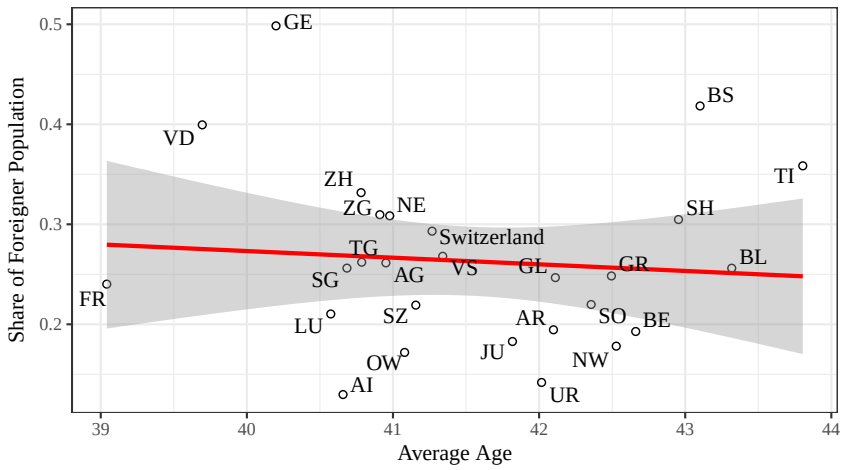

Figure7: Linear relation between the presence of foreign resident population (permanent, non permanent) and the average age in the different cantons in 2014. Sources: ESPOP, STATPOP.

who is older due the years of education accomplished. On the other hand, "younger" cantons with lower rates of foreigners are Lucerne (LU), Appenzell Inn. (AI), just to mention, but a few.
Historical data photograph a situation where migration stocks remain an important source of workforce, but they are ageing at almost the same pace as natives. Such shift seems to be caused by a positive skill selection. Therefore, if on the one hand, the more recent migrants have a less beneficial age structure to support the dependency ratios, on the other they seems to have an education level which can boost the Gross Domestic Product (GDP) and productivity compensating the ageing by the economic growth.

Forecasts

The computation of the evolution of the pension system requires a prior stage: the population forecasts. For the purposes of the analysis I treat the forecasts of the Swiss nationals and foreigners separately. I exclusively focus on the latter, whose evolution is more unstable due to effects of migration flows, while for Swiss nationals the projections of the SFSO are left untouched[3]. The difficulties in forecasting migration flows lies on their sensibility towards hard predictable shocks, such as business cycles, wars, etc. For this reason, *ad hoc* immigration forecasts are elaborated hereafter by relying on the results of the comparative study on immigration forecast methods by Milivinti and Benini (2017). The outcomes of the migration flows forecasts are then used to compute the stock of future foreign population using the cohort component method. In a second step, the predictions for the whole Swiss population are obtained by summing my predictions of the foreign population stocks to the SFSO projections of the native population ones.

[3]This choice makes this study relying on the assumptions on Swiss nationals emigration and immigration made by the Swiss Federal Statistical Office. A closer look to the in- and out- migration of Swiss citizens in the past years shows a pretty steady series with approximately 28,000 people leaving and 26,000 re-entering the country.

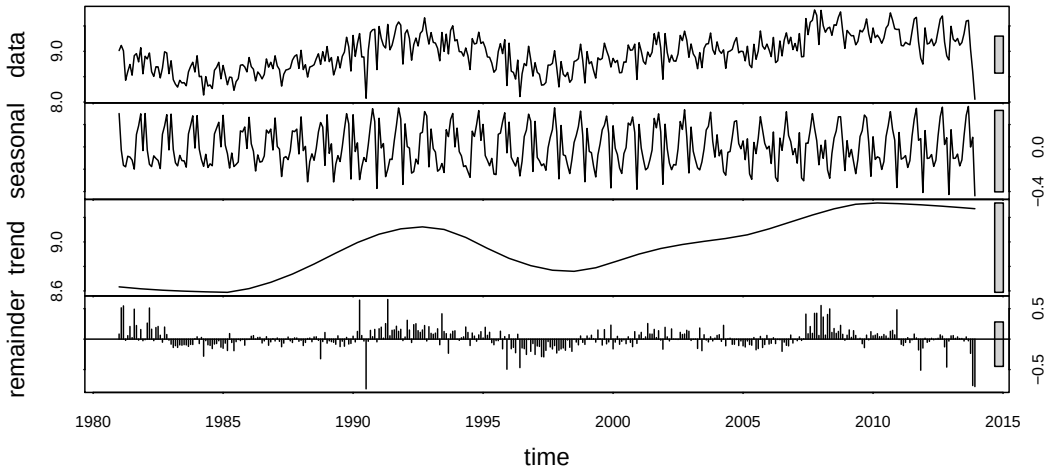

Figure8: Immigrant Flows Decomposition. From the top to the bottom, the plots show: observed data, global trend, seasonal trend and random noise.

Immigration and Foreign Population Forecasts

Immigration Flows

Among the different predictors of the population change the most challenging to forecast, due to its instability and high degree of randomness, is the number of immigrants. The prediction exercise of the immigration time series is undertaken following Milivinti and Benini (2017). The latter compares different models to find the best predictive one within a Bayesian approach. The starting point is to simple decompose the logarithm of the number of monthly arrivals (y_t) into a time and a seasonal trend,

$$y_t = \text{trend}_t + \text{seasonality}_t + \text{e}_t. \tag{1}$$

where, seasonality_t s decomposed into a Fourier decomposition of order 2.
A visual inspection of the decomposition, Figure 8, confirms the presence of a seasonal pattern in the population inflows. The decision to treat immigration as a seasonal phenomenon, rather than an annual, will be an essential choice to improve the prediction accuracy. Such leap forward is achieved through the introduction of an interaction between global trend and seasonality in the simple model of trend-seasonal decomposition. Hence, an efficient way to model seasonal cycles, whose amplitude depends upon the global trend, is translated into mainly three alternatives, which progressively relax any restrictive functional form's assumptions. In such setting a semi-parametric additive and a non-parametric specification are compared alongside with a linear one to model the trend-seasonal interactions. The results have shown the semi-parametric formulation to out-perform the alternatives both for shorter and longer time horizons. According to the authors' advices the additive model with a semi-parametric global trend is preferable for short-term forecasts, while the additive model with linear trend is able to guarantee stability even in long-run forecasts. Thus, the latter is employed here and it will take the following form:

$$y_t = \beta_0 + \beta_1 \text{trend}_t + \sum_{i=1}^{2} f_{2i}(\cos_{it} + \sin_{it}) + \sum_{i=1}^{2} f_{3i}(\text{trend}_t, \cos_{it} + \sin_{it}) + \epsilon_t, \tag{2}$$

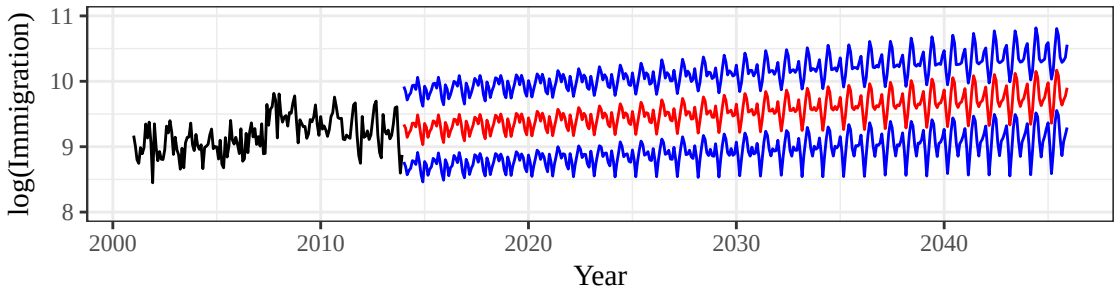

Figure9: Semiparametric additive model results for the aggregate immigration forecasts between 2015-2045 with 95% prediction credible interval from the posterior predictive distribution. The values of immigration on the vertical axis are in logarithms.

where seasonality$_t$ is simply re-defined as the sum of two trigonometric functions and a monthly specific effect which is further interacted with the global trend. The flexibility of the additive model is fully exploit within a Bayesian approach to forecast the future of Swiss migration. I adopt here the same prior used by Milivinti and Benini (2017) for the middle scenario predictions with the smooth functions computed on three knots: $\beta_0 \sim N(9; 0.5)$, $\beta_1 \sim N(1; 0.1)$, $\sigma_\epsilon, \sigma_\theta, \sigma_{\tilde{\delta}} \sim HN(0; 2)$, where σ_θ and $\sigma_{\tilde{\delta}}$ are specific standard deviations of the parameters of the penalized likelihood built to compute the thin plate regression splines[4].
The forecasts obtained stand for the whole amount immigration flows. They have been performed at the aggregate level, e.i. for all ages, to guarantee more stable predictions[5]. In fact, because of the stability of the foreigners' newcomers the age distribution across years (see also Figure 4), once the results in Figure 10 are computed, I disaggregate them by simply multiplying the total foreign population by the age distribution.

Immigration Stocks
For developing the consecutive steps of the analysis it is necessary to convert them into migration stocks:

$$Stock_{age,t} = Stock_{age,t-1} * \%Stay_{age,t} + Inflows_{age,t} + Births_t - Deaths_{age,t},$$

where $Stock_{age,t-1}$ is the foreign resident population at time $t-1$ for a specific age age, $\%Stay_{age,t}$ is the stay rate, $Inflows_{age,t}$ is the amount of new incomers resulting from the predictions of model (2), $Births_t$ is obtained by multiplying the foreign population reproduction rate by the total $Stock_{t-1}$ and $Deaths_{age,t}$ results from multiplying the death rate by $Stock_{age,t-1}$. Please notice that the naturalized population is still accounted for in the foreigner population. Since the current analysis focuses on the impact of migration on the AHV/AVS and the effects of the naturalized population would still fall into the one of the migrant population. The reproduction rate and the death rate for the period 2015-2045 are drawn from the SFSO forecasts. On the other hand, I did specific forecasts for the stay rate using an AIRMA models. The final results include the whole stock of foreign population residing in Switzerland until 2045, also taking into account the migrants' ageing. Figure 10 shows a comparison between the results of my foreign population forecasts for the middle scenario priors and the ones of the reference scenario of the SFSO. The two display almost the same values until 2030 while the divergence to 2045 is due by the higher predictions of the semiparametric model. Moreover, in Figure 11 I also compare

[4]For details see Milivinti and Benini (2017)
[5]See also the recommendations for the age categories in Milivinti and Benini (2017)

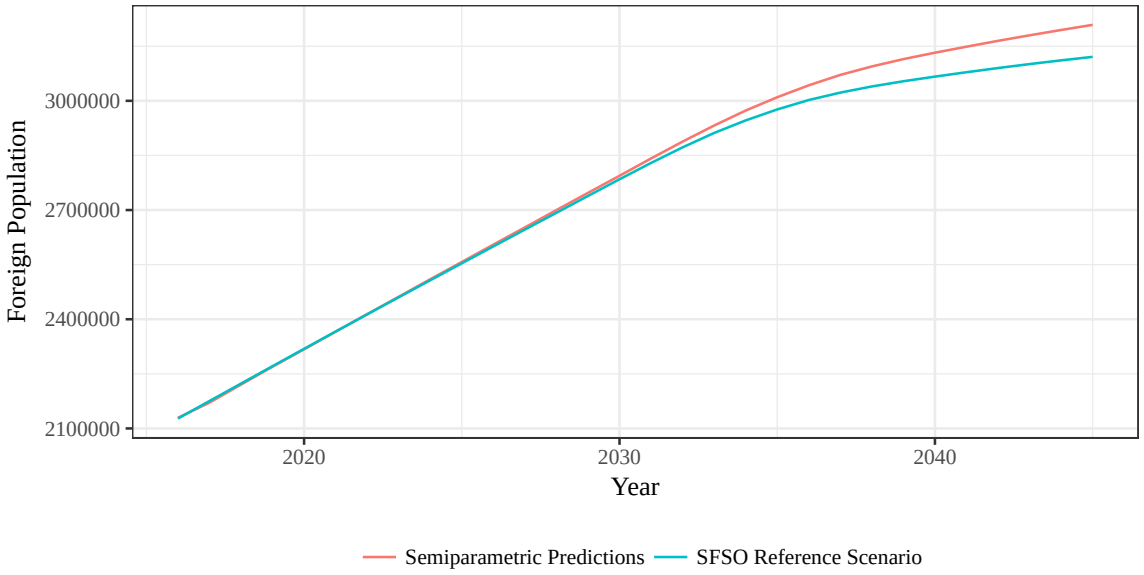

Figure10: Comparison between the SFSO foreign population forecasts reference scenario and the predictions elaborated from the semiparametric model between 2015-2045.

the age distribution of the foreign population between the two in 2045. While no important divergences can be found, which is probably due to the reliance of both forecasts on similar assumptions about mortality and fertility, my forecasts are slightly more optimistic than the ones of the SFSO, which forecast about 20 thousands less people between 0-14 years old and 20 thousands more between 65-100.

Figure 12 and 13 compares the foreign and native active population from 1980 to 2050 assuming the retirement to be fixed to 65, where the foreigners' forecasts are obtained with the current computations, while the natives' ones are drawn from the SFSO .

Results highlight that if in absolute terms the foreigner active population will continue to increase until 2045 (Figure 12), in relative terms such an increment is less remarkable and it seems to approach to a steady state by 2025 (Figure 4.13). Said differently, by 2025 the share of foreigner active population will not augment any more, but stay constant around the 80% of the total foreign population.

Another useful distinction for the next stages of this study is the population disaggregation into the twenty-six Swiss cantons. The first step in this direction is to consider the possibility to proceed in the same way as for the age categories, i.e. to obtain the disaggregated values by simply multiplying the aggregate forecasts by the foreigners' distribution across cantons. Figure 14 shows how the cantonal shares of foreign population[6], while less constant than the age distribution, still produce a distinct and regular pattern with Zürich having the largest share of foreigners, as well as variation (min. 0.15 max. 0.23), and Vaud being the second except for the period 1995-2002, in which it was surpassed by Geneva. Being the shares of all the other cantons far below, their variation appears less problematic from the absolute point of view of the disaggregation, even though potentially relevant in relative terms.

In light of such considerations, and after having also performed a disaggregate forecast for the single cantons, still the best approach in terms of mean square errors, is to multiply the total

[6]The cantonal shares in Figure 14 are the number of cantonal foreign population with respect to the whole foreign Swiss population.

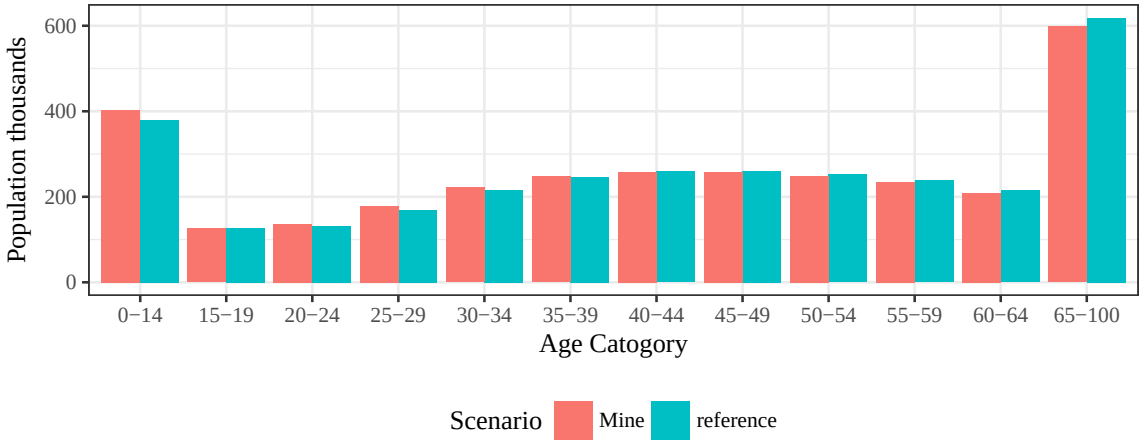

Figure11: Comparison of the age distribution of foreign population stocks between the SFSO foreign population forecasts reference scenario and the predictions elaborated from the semi-parametric model in 2045.

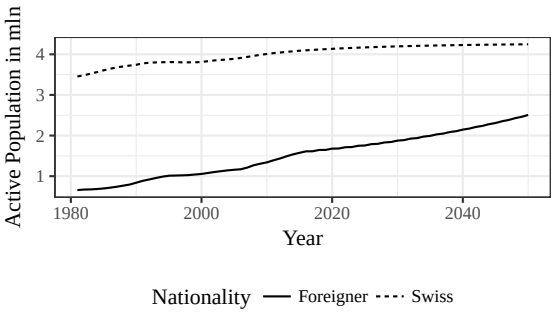

Figure12: Forecasts of the foreigner vs native active population (15-65 years old) until 2045, where the black solid line denotes the foreigners and the dotted the Swiss.

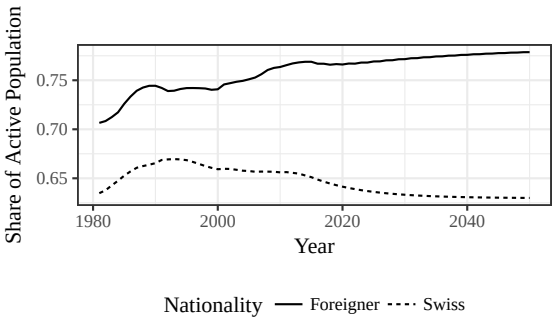

Figure13: Forecasts of the foreigner vs native shares of active population (15-65 years old) within each category until 2045 where the solid line denotes the foreigners and the dotted the Swiss.

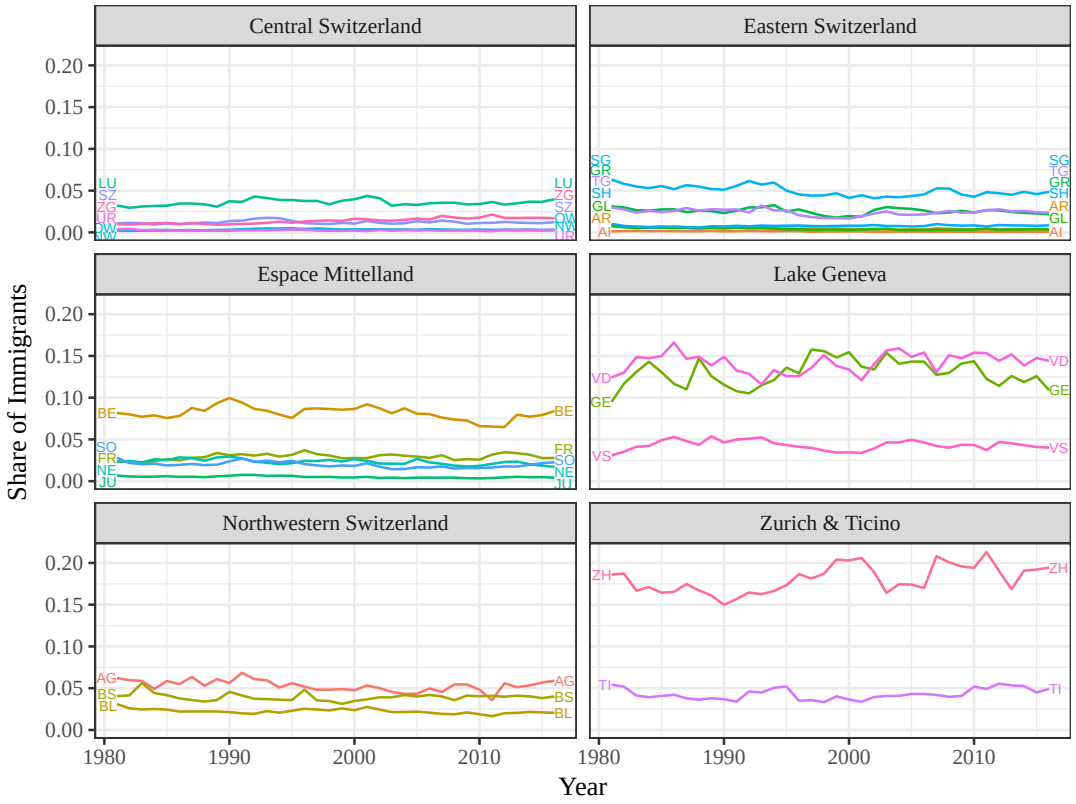

Figure14: Evolution of the cantonal foreign population as a percentage of the whole Swiss foreign population between 1981 and 2045. Sources: ZAR and STATPOP.

population by the regional distributions[7]. The cantonal foreign population forecasts obtained will be used in the next step of the analysis.

Population Forecasts

The second category of forecasts needed concerns the cantonal total population. The evolution of the whole population depends upon different components, such as the survived population, the births and the net migration. Among those three the first two are the easiest to forecast since they hardly show trend inversion, while the latter is the most unstable and difficult to predict. Hence, in order to have the most possible accurate population predictions I will sum to the reference scenario calculated by Swiss Federal Statistical Office (2015b) for the native population, which also takes into account the migration flows of Swiss citizens, the forecasts for the stock of foreigners elaborated in the previous subsection, which shows a steady and gradual increase with some slowdowns, but no trend inversions. Swiss Federal Statistical Office (2015a) reports all the hypothesis on which the SFSO bases its population projections are available. No additional assumptions or modifications are made by the author with regard to internal migration, or migration of Swiss nationals.

[7]Further evidence in support of this decision has been confirmed by checking the Akike Information Criterion, for different specifications of ARIMA models. The best model for all regions ends out to be a random walk, except for Zug and Nidwalden for which an AR(1) is preferable.

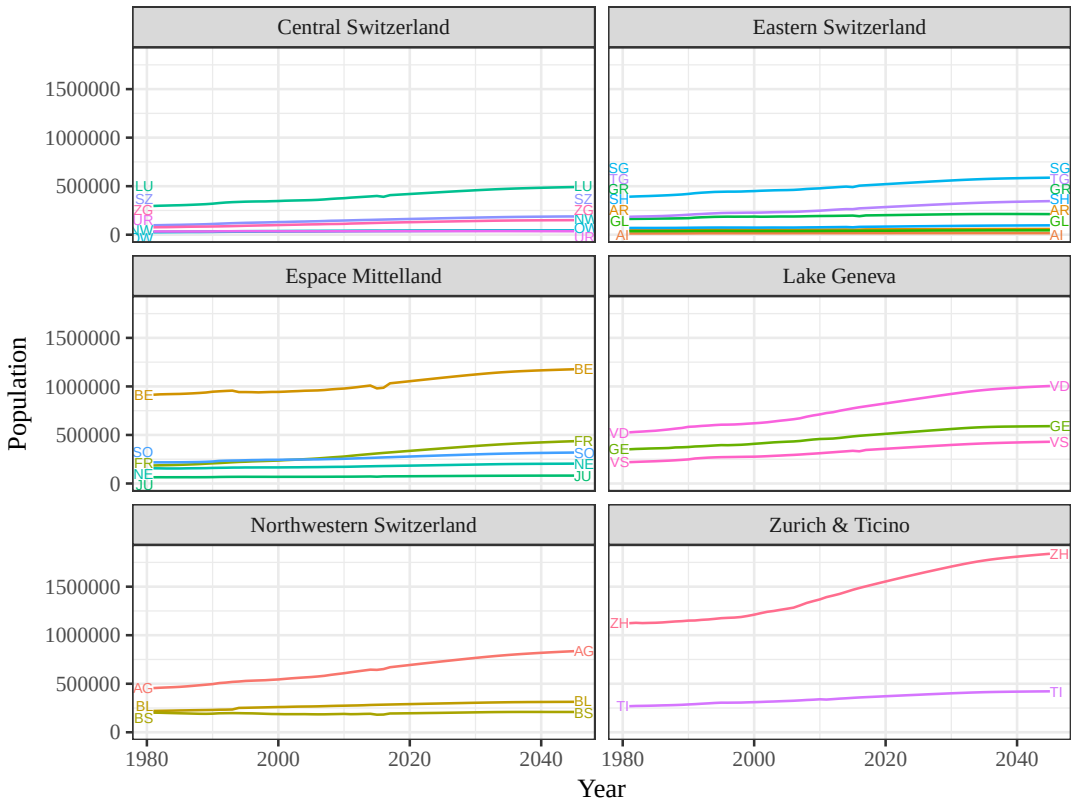

Figure15: Evolution of the total population by canton between 1981 to 2045. Source: "2015-2045 scenarios concerning the cantonal permanent population", Swiss Federal Statistical Office, ZAR and STATPOP.

The Swiss Pension System

The Swiss AHV/AVS is a PAYG system pensions, which simply transfers the active population's contributions to the retired. It can be watched as an equilibrium where: Pension Benefits = Contributions. As a conventional benefit system, the AHV/AVS fixes the pension amounts based on the average earnings and the number of contribution years. The pensions, as well as the corresponding entitlements, are subject to an hybrid indexation system, which is an equal combination of price and nominal wage growth (*Mischindex*[8]).
The AHV/AVS is highly re-distributional since the maximum pension equates to twice the minimum pension, depending on individual contribution years. Moreover, differently from others pension schemes, the Swiss one is not exclusively linked to an active labour participation since every individual, irrespectively if employed or not, is covered and must pay a minimal yearly contribution of 478 Swiss francs. The contributions of the active labour force, instead, amounts to the 8.4 % on the actual income for employed workers (paid equally between the employer and the employee)[9].
According to (BSV, 2015), the AHV/AVS is primarily financed by contributions (71 %) and public subsidies (24 %). The latter primarily includes: a small buffer fund, which corrects for short-term unbalances[10], and public contributions[11]. Additionally to public subsidies connected to pension, also subsidies from general tax revenue also play a significant role in financing the pension system. In the Swiss case, in fact, the 0.83 % of the value added tax (VAT) and a fraction of the revenues from state-owned casinos are used to finance the old-age pension system. However, the correct specification of their contribution on base year pension liabilities can be hard.

The Future Situation: a Base Case Scenario

How will the AHV/AVS balance sheet look like in 2045 if the population evolution will take the shape of the one elaborated in the previous sections? As a simplistic illustrative example I try to multiply the average pension in 2014 by the future retired population until 2045 also adjusting for the hybrid indexation system. According to the 2013 Swiss Parliamentary report (Bundesrat, 2013) about the overall view on the financing perspectives of social insurance until 2035, an annual labour productivity rate of 1 is assumed. By the same token, the active population forecasts are multiplied by the mean contribution, which also accounts for the productivity growth. According to my calculation shown in Figure 16 in 2014 the contributions of the active population covered the 75 % of the old age pension allowances. Those figures slightly differs form the ones of the BSV (2015), which reports the AHV/AVS to be primarily financed by contributions (71 %) and public subsidies (24 %). Some divergences might be due to different accounting of invalidity and other allowances. However, the graph shows the contributive capacity of the active population will be increasingly insufficient to sustain the pension system, which would need to be financed through other sources. However, the years until 2045-2050 are known to be the most problematic since they coincide with the retirement of the baby boomers. In fact, in 2045 the contributions capacity to cover the pension costs will

[8] $Mischindex = (0.5 \times \text{Wage Index} + 0.5 \times \text{Consumer Price Index})$.
[9] For self-employed the percentage drops to 7.8%, however, for reasons of simplicity the 8.4% will be applied.
[10] The reserves of the Swiss buffer fund of the old-age pension system (AHV-Fonds) amounts to around 1.2 times the annual expenditures.
[11] The present value of federal contributions is the 19.55% of AHV/AVS related expenses

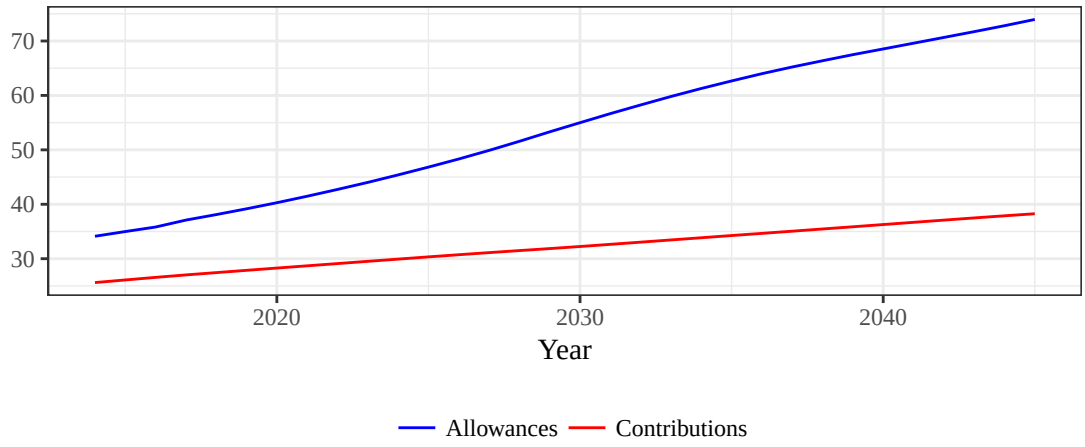

Figure16: The blue line represents the pension allowances according to the population forecasts of section 4.2, while the red line the pension contributions in billionf of Swiss Francs (CHF) between 2014 and 2045.

be of the 55 %. Once that generation would pass away, the AHV/AVS expenses would decrease and slowly rematch the contributions. However, the question on how the AHV/AVS should balance its passives remains an open question. Among the different options, such as an increase of the retirement age, a change in the indexation, a cut of the pensions, etc. the main focus here is the potential role of migrants. While Figure 16 already takes into consideration the increase in net migration in the next years predicted by the model 2, this is far from enough.

Model

This section presents an adaptation of the paper by Gil-Alonso (2012) on which the current analysis is based. Following up form section 5, in the Swiss system the pension benefits are financed by the contributions of the employed population, by a small buffer fund, which corrects for short-term unbalances[12], and public contributions[13].

Pension Benefits = Workers' Contribution + Buffer Fund + Public Contributions.

The total benefits corresponds to the number of retired people R multiplied by the average pension p. The increase of the pension benefits due to the indexation regime *Mischindex* would be disregarded. On the one hand, the inflation would be superfluous since the analysis is carried out in real terms. On the other, the part of the indexation relying on the wages' growth, is first assumed to be zero and only adapted in the *ceteris paribus* analysis when the compensatory action of a productivity growth is considered. On the righten side of equation 3, the contributions of the active labour force (E) corresponds to a fraction, the contribution rate (c), of the average income $\bar{y}$, which will be substituted by the GDP per employed in the analysis, and a set of other contributions
$A =$ Buffer Fund + Public Contributions. The equilibrium can be rewritten as:

$$R \times p = E \times \bar{y} \times c + A, \tag{3}$$

[12]The reserves of the Swiss buffer fund of the old-age pension system (AHV-Fonds) amounts to around 1.2 times the annual expenditures.
[13]The present value of federal contributions is the 19.55% of AHV/AVS related expenses

From Figure 16 A approximately accounts for the 25 % of the pension benefits in 2014 ($A = 0.25 \times (R \times t \times GDP/E)$. Since the focus is drawn on the role of the population evolution (R and E) and not in the one of A, the rest of the study is focusing on the development of the other model's parameters necessary to maintain the 2014 level of funding, i.e. that $E \times \bar{y} \times c$ would equal the 75 % of the total contributions. Equation 3 can be rewritten as:

$$0.75 \times (R \times t \times GDP/E) = E \times GDP/E \times c, \tag{4}$$

where, t is the "transfer ratio", that is the ratio between the average pension and income $\left[t = \frac{p}{\bar{y}}\right[$. The transfer ratio is unobserved, but it can be calculated by simplifying and re-arranging equation (4) to obtain:

$$t = \frac{E \times c}{0.75 \times R} = 1.33 \times E/R \times c. \tag{5}$$

The elementary formulation of the accounting model presented overlooks at some components potentially affecting the balance sheet of the AHV/AVS by inevitably making some crucial assumptions. First, the Swiss pension formula, for which the maximum pension equates to twice the minimum pension depending upon individual contribution years, is constrained to a large degree of redistribution. However, the simplicity of the model, which implicitly assumes a constant wage distribution over time, overlooks the potential effects of the redistributive asset of the AHV/AVS. Second, since the accounting exercise is carried on as a *ceteris paribus* analysis, GDP and productivity growth are assumed to be unaffected by the other model's parameters, such as the number of migrants or of retired. Third, since the analysis does not utilize wages, but average GDP per employed person to compute the contributions, I assume wages to be a fixed share of the GDP for the period under study.
According to the model, the sustainability of the pensions system is achieved when the total revenues equalize the expenditures, without widening relative role of A. The analysis looks at the evolution of the Swiss pension system from 2014 to 2045 and it considers what is needed in terms of contributors to keep the system at the *status quo* of 2014 in relative terms. In such model the only shock examined is the increase in the number of retirees. The investigation is developed by studying the change of one parameter at the time while keeping all others constant (*ceteris paribus*). Hence, in the first stage the only compensatory action is the employment increase, while in the second, a bunch of alternatives, such as the expansion of the contribution rate, GDP and transfer ratio are tested one at the time.

The Initial Situation in 2014

In this section the situation of the AHV/AVS in 2014 is illustrated for the 26 cantons and for Switzerland. Even though all the parameters are displayed at the cantonal level, the only purpose of such disaggregation is to depict how cantonal demographic differences would shape the costs and benefits caused by different federal actions, rather than the analysis of the cantonal balance *per se*. The model's parameters, as well as other indicators, are displayed in Table 1. Column (1) and (3) show the indicators about the ageing population, which respectively represent the number of retired persons (R) and the old dependency ratio (ODR), i.e. number of retired persons per 100 employed persons[14]. The canton with the lowest ODR is Geneva,

[14]Since according to the data about 10% of the people aged 65 and older, which is the official retirement age, are employed, I did not consider all the population over 65 to be retired, but I included that 10% into the active one.

where there are 19.60 retired per 100 employed people, while the one with the highest is Bern where the retired are 27.70. The federal average ODR is 23.90[15]. Column (2), (4) and (6) show the data about the employment situation correspondingly denoting the number of employed persons (E) in Switzerland, including cross-borders, the employment rate (ER), i.e. the number of employed persons per 100 in their working age, and the residing working age population (WAP_{15-65}), i.e. the population between 15 and 65 years old. The discrepancies between ER and the ratio between E and WAP_{15-65} is given both by the 10% of the old population who is still at work, as well as the cross-border worker, which are considered in E, but not in the active resident cantonal population WAP_{15-65}. The canton with the highest employment rate is Nidwalden with 79.30%, while the canton with the lowest is Ticino with 73.6%. The Swiss ER amounts to 76.6%[16]. The parameter C indicates the amount of workers' contributors used to finance the AHV/AVS. The calculations stem from the data OECD (2015), OECD (2017) and are simply obtained by multiplying the cantonal GDP by the contribution rate on pensions (8.4%). These numbers help to understand which cantons are beneficiaries and which cantons are contributors. For example, if we multiply the number of retired persons by the average pension benefit and we compare the result with C we observe that the first contributor is Zürich, followed by Geneva and the first beneficiary is Valais followed by Uri. Last but not least, the transfer ratio t, relating the mean pension to the GDP per employed $\left[t = \frac{p}{GDP/E}\right[$, surpass the Swiss average of 0.35 in the cantons of Lucerne, Zürich, Basel-Stadt, Aargau, Schwyz, Vaud, Thurgau, Zug, Fribourg and Geneva (0.43). Differently said, the cantons with $t > 0.35$ are contributors while the cantons with $t < 0.35$ are beneficiaries in terms of transfers to the AHV/AVS.

The Evolution up to 2045

Once the initial situation has been described (see subsection 7.1), the effects of an ageing population until 2045 can be assessed. I will develop a *ceteris paribus* analysis where the different outputs reported in Tables 2 and 4 represent the compensatory changes in each of the parameters necessary to maintain the system at the 2014 *status quo*.
The number of retired people reported in column (1) is determined by the results of the population forecast of section 4.2 assuming the retirement age to be fixed at 65 years old. The columns from (2) to (9) simply show the actions required, in terms of employment augmentation, to neutralize the increase in the retired population. Notice that both the number of retired people (R), as well as the working age population (WAP_{15-65}, ΔWAP_{70}), already include the foreign population forecast.
By keeping the retirement age at 65 years old, the Swiss retired population will jump from 1,318,971 to 2,463,643 people, which is an increase of 84.7%. By the same token the Swiss ODR will rise from 23.9 in 2014 to 43.30 in 2045. One way to keep the ODR at the same level as in 2014 is to increase the employment at the same pace as the retired population. Column (4) illustrates the values of the percentage annual increase in employed people maintaining the base year equilibrium. Results show that Switzerland should increase its employment by 1.4% yearly from 2015 to 2045. Similarly, the employment rate should rise to +142%. Therefore, despite the upsurge in the working age population (from 5,835,330 in 2014 to 6,743,326 in 2045),

[15]Above the Swiss ODR we find in order from the lowest to the highest Obwalden, Neuchâtel, Jura, Ticino, Appenzell Inn., Nidwalden, Solothurn, Appenzell Aus., Schaffhausen, Glarus, Graubünden, Valais, Basel-Land., Uri and Bern.

[16]The cantons below the federal average ER are from the lowest to the highest: Fribourg, Uri, Basel-Land., Valais, Jura, Necuhâtel, Vaud, Basel-Stadt, Geneva and Ticino.

Table1: Main parameters of the model in 2014 in the 26 Swiss cantons.

Canton	R	E	ODR	ER	C	WAP_{15-65}	t
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Aargau	96,612	426,693	22.60	78.30	2,292	453,435	0.37
Appenzell Inn.	2,578	10,231	25.20	79.30	56	10,601	0.33
Appenzell Aus.	9,050	34,751	26.00	78.10	176	36,532	0.32
Bern	181,093	653,606	27.70	78.90	4,428	669,115	0.30
Basel-Land.	53,112	194,693	27.30	77.00	1,108	202,198	0.31
Basel-Stadt	34,978	154,343	22.70	76.10	1,794	161,934	0.37
Fribourg	40,291	190,827	21.10	77.60	1,012	207,640	0.40
Genève	70,932	362,317	19.60	74.60	2,790	397,523	0.43
Glarus	6,735	25,623	26.30	78.40	154	26,812	0.32
Graubünden	34,626	131,860	26.30	78.20	800	136,951	0.32
Jura	12,802	51,341	24.90	76.60	269	53,998	0.34
Lucerne	59,674	254,347	23.50	78.50	1,475	269,079	0.36
Neuchâtel	29,368	120,557	24.40	76.60	856	128,379	0.34
Nidwalden	7,033	27,671	25.40	79.30	169	28,600	0.33
Obwalden	5,656	23,607	24.00	78.20	136	25,027	0.35
St. Gallen	76,763	323,507	23.70	78.10	2,070	343,266	0.35
Schaffhausen	14,458	55,308	26.10	78.00	390	57,222	0.32
Solothurn	44,548	171,721	25.90	78.50	994	179,165	0.32
Schwyz	22,604	99,001	22.80	78.40	516	105,355	0.37
Thurgau	38,984	173,806	22.40	78.30	915	185,350	0.37
Ticino	67,990	270,740	25.10	73.60	1,658	289,581	0.33
Uri	6,213	22,475	27.60	77.20	106	23,730	0.30
Vaud	111,245	494,638	22.50	76.30	2,969	540,277	0.37
Valais	55,123	209,814	26.30	76.70	999	224,682	0.32
Zug	17,500	77,772	22.50	78.30	1,035	82,886	0.37
Zürich	219,003	946,311	23.10	78.70	7,991	995,994	0.36
Switzerland	1,318,971	5,507,558	23.90	77.60	37,158	5,835,330	0.35

R: Number of Retired people.
E: Number of Employed people in Switzerland including permanent, non-permanent residents and cross-border workers.
C: Amount of cantonal contributions to old age survivors' pension in millions of US dollars, constant prices, constant PPP with base year 2010.
t: Transfer ratio ($t = E/R \times c$) needed to keep the model in equilibrium.
ODR: Old Dependency Ratio.
ER: Average cantonal employment rate obtained by averaging the age-nationality specific employment rates
WAP_{15-65}: Resident Working Age Population, i.e. people between 15 and 65 years old.

the additional number of employed people would amount to 3.1 millions. Given the low birth rates, such fresh workforce is supposed to be supplied by migration flows.
From a cantonal prospective large differences are observed, with the lowest increase in old age population is observed for Basel-Stadt passing from 34,978 to 48,585 (+38.9%) and the largest for Schwyz going from 22,604 to 50,787 (+124.7%). Geneva has the lowest ODR with 27.2 retired people for 100 employed and Valais bares the heaviest burden with 52.5 retired people for 100 employed. Large internal disparities are also observed for the employment, ranging from 0.35% for Basel-Stadt to 2.19% for Schwyz and for the employment rate, which would experience the lowest predicted increment for Basel-Stadt and Geneva (+101-102%) and the highest for Obwalden (+194%).

Table2: Main parameters of the model in 2045 in the 26 Swiss cantons if the increase in employment is the only compensatory actions.

Canton	R	ODR	WAP_{15-65}	$E^*(\%)$	$ER^*(\%)$	ΔE^*	ΔImm^*	$\Delta FP^*(\%)$	ΔWAP_{70}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Aargau	203,634	46.30	524,920	1.90	150	347,343	394,118	148	42,940
Appenzell Aus.	15,467	44.10	35,994	1.27	144	16,861	18,590	140	3,253
Appenzell Inn.	4,434	43.30	10,196	1.33	151	5,161	5,735	145	948
Basel-Land.	82,886	40.30	212,879	0.83	125	59,971	67,838	69	17,184
Basel-Stadt	48,585	28.90	184,659	0.35	102	19,373	21,671	21	9,954
Bern	305,198	46.40	690,927	1.24	139	306,225	346,755	140	64,937
Fribourg	89,384	46.60	267,984	2.15	138	178,666	206,403	165	18,691
Genève	126,494	27.20	559,066	0.63	101	99,826	112,492	36	25,399
Glarus	11,986	46.80	26,942	1.44	148	14,293	16,015	109	2,532
Graubünden	60,302	43.40	135,061	1.20	149	62,097	69,322	133	12,709
Jura	21,341	36.80	59,699	0.83	125	16,908	18,894	118	4,401
Lucerne	115,565	45.10	299,363	1.69	144	174,663	197,328	184	24,463
Neuchâtel	46,258	35.10	146,889	0.75	113	34,494	38,973	57	9,542
Nidwalden	12,695	45.60	25,127	1.47	174	15,866	17,345	197	2,715
Obwalden	12,325	51.50	23,191	2.06	194	21,085	23,067	317	2,598
Schaffhausen	25,752	44.40	63,623	1.29	135	28,249	31,615	103	5,415
Schwyz	50,787	51.10	110,214	2.19	177	95,244	105,924	210	10,731
Solothurn	80,750	45.90	194,525	1.42	140	96,475	109,405	126	17,083
St. Gallen	143,556	43.10	369,965	1.51	143	196,632	222,831	125	30,219
Thurgau	87,267	47.80	219,585	2.03	155	157,731	176,619	161	18,410
Ticino	126,462	38.00	358,940	0.91	123	107,602	117,611	78	25,026
Uri	11,084	49.30	19,208	1.45	183	12,605	14,087	206	2,303
Valais	111,677	52.50	258,325	1.82	144	159,104	179,335	145	23,067
Vaud	216,385	41.00	682,804	1.52	123	313,985	356,942	89	44,465
Zug	34,873	44.40	92,328	1.78	147	57,084	65,281	128	7,356
Zürich	391,496	41.00	1,170,913	1.42	126	524,205	592,284	102	83,045
Switzerland	2,436,643	43.30	6,743,326	1.40	142	3,121,747	3,526,479	110	509,388

$E^*(\%)$: percentage of annual increase in the employed people necessary to maintain the model as in the base year 2014.
ER^*: percentage increase in the employment rate necessary to maintain the model as in the base year 2014.
ΔE^*: employed people necessary to maintain the model at the same equilibrium situation as in 2014 maybe through immigration.
ΔImm^*: Number of new immigrants, necessary to maintain the model as in the base year 2014.
$\Delta FP^*(\%)$: Percentage increase in foreign population necessary to maintain the model as in the base year 2014.
WAP_{70}: Workforce available if the retirement age is postponed to 70 years old.

Column (7) reports the values of new total immigrant population necessary to provide the ΔE^* of column (6) while keeping the foreign population employment rates fixed at the 2014 values. The difference between ΔE^* and ΔImm^* is given by the inactive migrants. As previously said, ΔImm^* represents an additional immigration to the one already forecast by the semiparametric model in subsection 4.1.
To have a more direct interpretation of such values, Column (8) translates ΔImm^* into percentages. For Switzerland it would mean to increase its foreign population by +110% with the lowest increase necessary for Basel-Stadt (+21%) and Geneva (+36%) and the largest by Obwalden (+317%) far followed by Schwyz (+ 210%).
Finally, the increase of the retirement age is another option to widen the employed population. In column (9) I report the number of people that would become part of the active population, and would therefore exit from the retired one, if the retirement age would be risen to age 70. Table 3 reports the adjustments in the model's parameters in that case. Such solution would be enough to fill the required workforce almost only for Basel-Stadt, but it will lower the need for foreign population to the 80% at the federal level.
Despite the magnitude of those numbers, it is important to remind that the current *ceteris paribus* analysis is assuming that the employment variation is the only measure taken to balance the system, while all other parameters (for example the GDP, the productivity, public expenditure, etc.) are kept constant at their 2014 level. In fact, the figures given here represent a sort of worst case scenario since we could expect, for example, a positive GDP and productivity trend, which might even be fostered by immigration. According to (Liebig and Mo, 2013), which has studied the impact of the cumulative migration waves arrived over the past 50 years in OECD countries, suggests that migrations' impact on the GDP is on average close to zero, rarely exceeding 0.5% in positive or negative terms with the exception of Switzerland and Luxembourg, where immigrants provide an estimated net benefit of about 2% of GDP.
The evolution from 2014 to 2045 of the results just discussed is portrayed in Figure 17, which shows the trend of the active population (AP) and the number of employed people (E^*) to keep the equilibrium. The blue shaded area illustrates the deficit in workforce the system will face. Notice that I included in the active population also a 10% of people who have already achieved the retiring age of 65, but are still employed, as well as the predicted cross-borders. According to the results, the labour market will be self-sufficient until the 2020, while from 2021 on it will need to be filled with new workforce, i.e. immigration.

Table3: Main parameters of the model in 2045 in the 26 Swiss cantons if the retirement age is 70 years.

Canton	R	ODR	WAP_{70}	$E^*(\%)$	$ER^*(\%)$	ΔE^*	ΔImm^*	$\Delta FP^*(\%)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aargau	160,694	36.60	524,920	1.60	135	270,116	306,491	115
Appenzell Inn.	3,486	34.10	10,196	1.00	136	3,599	3,999	101
Appenzell Aus.	12,214	34.80	35,994	0.90	130	11,794	13,003	98
Bern	240,261	36.50	690,927	0.90	126	209,543	237,277	96
Basel-Land.	65,702	31.90	212,879	0.50	113	34,959	39,545	40
Basel-Stadt	38,631	23.00	184,659	0.00	92	2,248	2,515	2
Fribourg	70,693	36.90	267,984	1.80	125	143,059	165,268	132
Genève	101,095	21.70	559,066	0.30	92	50,855	57,307	18
Glarus	9,454	36.90	26,942	1.10	134	10,360	11,608	79
Graubünden	47,593	34.30	135,061	0.90	134	42,404	47,338	91
Jura	16,940	29.20	59,699	0.50	114	9,957	11,126	69
Lucerne	91,102	35.50	299,363	1.30	130	131,966	149,090	139
Neuchâtel	36,716	27.90	146,889	0.40	103	19,060	21,535	32
Nidwalden	9,980	35.80	25,127	1.10	156	11,427	12,492	142
Obwalden	9,727	40.60	23,191	1.70	175	16,671	18,239	251
St. Gallen	113,337	34.10	369,965	1.20	129	144,903	164,209	92
Schaffhausen	20,337	35.10	63,623	1.00	122	19,848	22,213	72
Solothurn	63,667	36.20	194,525	1.10	126	69,534	78,853	90
Schwyz	40,056	40.30	110,214	1.80	159	76,048	84,576	168
Thurgau	68,857	37.70	219,585	1.70	140	124,286	139,169	127
Ticino	101,436	30.50	358,940	0.60	113	70,895	77,490	52
Uri	8,781	39.10	19,208	1.10	165	9,286	10,378	152
Vaud	171,920	32.60	682,804	1.20	112	236,543	268,905	67
Valais	88,610	41.60	258,325	1.50	131	124,438	140,262	113
Zug	27,517	35.00	92,328	1.40	132	43,766	50,051	98
Zürich	308,451	32.30	1,170,913	1.10	114	376,824	425,763	74
Switzerland	1,927,257	34.20	6,743,326	1.10	128	2,264,390	2,558,703	80

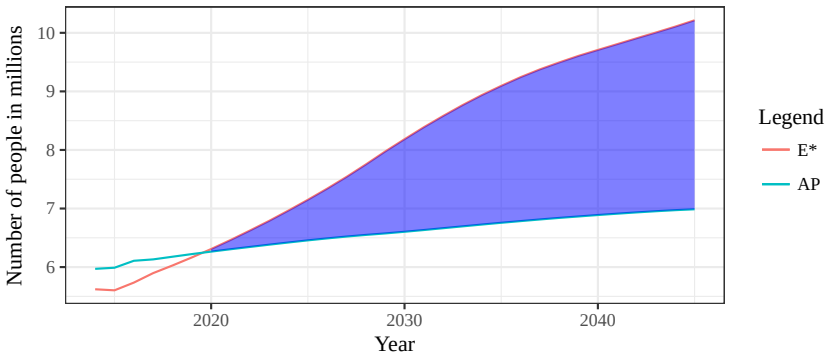

Figure17: The blue line represents the change in the active population (AP), according to the population forecasts of section 4.2, while the red line the number of employed people (E*) maintaining the model in equilibrium between 2014 and 2045. The blue shaded area represents the number of workforce needed to keep the system as in its base year.

Nevertheless, the increment of the employment is not the unique solution and, as just seen, it is not enough as a remedy *per se*. Hence, Table 4 shows alternative compensatory actions. Column (1) and (2) consider the changes in the contribution rate and in percentage points under the assumption of a steady GDP per employed person. For the aggregate Swiss context the percentage of contribution rate to the pensions should rise from 8.4% in 2014 to 13.9% in 2045. However, if a contribution rate of approximately 14% would be imposed to all the cantons, the most penalized ones will be Basel-Stadt, Neuchâtel, Basel-Land, Bern and Jura, which report percentage adjustments below 12.7%. On the other hand, Valais, Aargau, Thurgau, Obwalden, Fribourg and Schwyz would benefit the most since all of them would have had to increase their contribution rates to more than the 15.3%.
The average federal transfer ratio will lower from 0.35 to 0.21, which means that the 2014 value should be multiplied by 0.6 (column(4)). Instead, to keep $t_{2045} = t_{2014}$ the average pension should decrease by 37% (column(5)) in relation to the GDP per employed person. Said differently, an increase in GDP of 68.1%, which is 1.69% a year, is needed to keep the current level of pension rents. In terms of percentage growth such result sounds ambitious, but far from being too unrealistic, since the Swiss GDP grew at a rate of 1.75% between 2000 and 2017 despite the 2008-09 recessions and the OECD long term GDP growth forecast OECD (2018) foresees an average yearly increase of almost the 2% for Switzerland from 2015 to 2045. All other things constant, if such an expansion will actually take place, it should be self-sufficient to cover the rising costs of the old age insurance with no need of a further increase of the workforce beyond the natural migration increment already predicted by the semiparametric model. In line with my calculations, between 2015 and 2045, the average value in term of GDP of one additional employed person is 153 thousands USD[17], whereas the corresponding value of one additional migrant is of 135 thousands USD. This means that, keeping all other things constant, in case Switzerland would accomplish an hypothetical +1% annual GDP growth, the workforce and migrant population should respectively adjust to around $\Delta E^* = 1.6$ mln. and $\Delta Imm^* = 1.8$ mln. to balance the system.
Clearly, the compensatory actions just described have to be viewed as extreme cases, since the measures undertaken to preserve the pension system are likely to be a mix of adjustments of the different parameters. However, even if a policy mix is desirable, I would like to draw the

[17]US dollars at constant prices, constant purchasing power parity (PPP) with base year 2000.

Table4: Main parameters of the model in 2045 in the 26 Swiss cantons for alternative compensatory actions.

Canton	$c^*(\%)$	$cc^*(\%)$	t^*	ct	$\Delta p(\%)$	$\Delta GDP(\%)$	$\Delta GDP\text{y}(\%)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Aargau	15.90	7.50	0.20	0.53	−47.30	107.10	2.38
Appenzell Aus.	12.80	4.40	0.21	0.66	−35.00	62.10	1.57
Appenzell Inn.	12.90	4.50	0.22	0.65	−35.40	63.30	1.59
Basel-Land.	11.90	3.50	0.22	0.71	−28.80	46.10	1.23
Basel-Stadt	10.50	2.10	0.30	0.80	−20.00	28.10	0.80
Bern	12.60	4.20	0.20	0.67	−34.10	59.60	1.52
Fribourg	16.90	8.50	0.20	0.50	−49.90	120.10	2.58
Genève	13.50	5.10	0.27	0.62	−37.70	70.30	1.73
Glarus	13.50	5.10	0.20	0.62	−37.60	69.90	1.72
Graubünden	13.20	4.80	0.20	0.64	−36.20	65.70	1.64
Jura	12.70	4.30	0.22	0.66	−33.30	57.60	1.48
Lucerne	14.70	6.30	0.21	0.57	−42.60	87.50	2.05
Neuchâtel	11.70	3.30	0.24	0.72	−29.50	47.70	1.27
Nidwalden	13.60	5.20	0.20	0.62	−38.50	72.70	1.78
Obwalden	16.40	8.00	0.18	0.51	−49.00	115.50	2.51
Schaffhausen	13.40	5.00	0.20	0.63	−37.60	70.10	1.73
Schwyz	17.10	8.70	0.18	0.49	−50.50	123.50	2.63
Solothurn	13.50	5.10	0.20	0.62	−38.70	73.50	1.79
St. Gallen	14.00	5.60	0.21	0.60	−40.60	80.00	1.91
Thurgau	16.70	8.30	0.19	0.50	−50.40	122.50	2.61
Ticino	13.90	5.50	0.20	0.61	−40.30	78.80	1.89
Uri	13.30	4.90	0.19	0.63	−37.70	70.40	1.73
Valais	15.30	6.90	0.18	0.55	−45.20	97.60	2.22
Vaud	14.60	6.20	0.21	0.58	−42.90	88.40	2.06
Zug	14.90	6.50	0.21	0.56	−44.20	93.80	2.16
Zürich	13.40	5.00	0.23	0.63	−37.80	70.80	1.74
Switzerland	13.90	5.50	0.21	0.60	−37.00	68.10	1.69

$c^*(\%)$: contribution rate on old age survivors' pensions in 2045.
$cc^*(\%)$: increase in % points in contribution rate on old age survivors' pensions in 2045.
t^*: transfer ratio in 2045.
ct: Coefficient multiplying 2014 transfer ratios.
$\Delta p(\%)$: % change in average pension in 2045 if productivity remains constant.
$\Delta GDP(\%)$: % change in GDP in 2045 if the average pension (p) remains constant.
$\Delta GDP\text{y}\%)$: yearly % change in GDP in 2045 if the average pension (p) remains constant.

attention on which are the necessary and desirable actions for the Swiss nation and which are the ones that will mostly create internal inequalities.
The Swiss pension system provides a change in the pension benefits based on a hybrid index computed using 50% of the nominal salary index calculated by the SFSO and 50% of the Swiss consumer price index. To alleviate the burden of the natural increase of the mean pension benefit, Gil-Alonso (2012) suggests to index the pensions to prices rather than wages, solution embraced, for example, by Spain. In this way the rise in the average pension benefit would slow down with respect to the GDP per employed. Such move would most probably lower the Swiss transfer ratio (0.4) closer to the European average (0.23)[18]. Another common manoeuvre is to rise the contribution rate above 8.4% to the pensions.
Canton-specific preferable policies arise from the different ageing process each canton is facing. From a decentralized perspective, cantons, like Basel-Stadt and Geneva, which already have a high share of foreign population, should find a more viable solution to increase the employment to sustain the pension system in future years. Conversely, other cantons like Obwalden, Fribourg and Schwyz, should prefer a national homogeneous increase of the expenditure rates.

Conclusions

The imminent boom in the number of pensioners, caused by the retirement of the baby boomers, the low fertility rates and the increase of the life expectancy, is pushing a coherent reform of the pension systems at the top of the political agenda. As a contribution to the discussion, this report has tried to portray the future of the first pillar of the Swiss pension system.
So far Switzerland has been in a better situation than other European countries. One of the characteristics which might have partially contributed to this comparative advantage, beyond the high internal GDP per capita, is the 29% of foreign population, which lowered the average population age. However, this is becoming less and less true. The majority of new migrants has achieved tertiary education, which translates into more years spent for formation and older age when they experience labour migration. Nevertheless, their high skills may compensate their less beneficial age structure by boosting the Gross Domestic Product (GDP) and the productivity.
While the computation of the impact of immigration on the GDP remains beyond the scope of this study, I have concentrated on the possibility to avoid the shrinkage of the pension system through the injection of new workforce into the labour market. The results show that when immigration is considered as the only method to maintain the AHV/AVS at its 2014 state, the number of employed people should rise of an additional 3.1 millions beyond the 5.2 mln predicted by the population forecasts. In terms of migrants these numbers translate into a further 3.5 mln, increasing the total foreign population by 110%. At the same time a rise of the retirement age might be a feasible remedy to reduce the need of foreign labour force from 110% to 80%. An achievable solution requires a policy mix. For example, the required workforce significantly drops if the model accounts for a plausible GDP growth. Even when considering a conservative scenario, where the Swiss GDP would increase by +1% between 2015 and 2045, the number of employed persons would drop to 1.6 mln and of immigrants to 1.8 mln. Furthermore, no necessary increase in the labour force would be needed in case of an economic expansion pushing the GDP to a +1.69% per year. Behind the national picture, important disparities of the cantonal demographies should be considered by policy makers since alternative

[18]The European average data are taken from Gil-Alonso (2012).

compensatory actions will disadvantage some cantons while benefiting some other. Hence, any reasonable and equitable solution, calls for a combination of the compensatory actions.
Far from being exhaustive, the analysis leaves some important open issues such as, employment rates and GDP *ad hoc* forecasts, the potential role of inflation and the relation between migration and GDP. Moreover, Switzerland has been considered as a sort of "island" unaffected by anything happening outside its borders. Immigration has been forecast exclusively using the Swiss immigration historical data while its relations with important pulls factors, such as the GDP per capita, have remained unexplained. Further research would benefit not only from the incorporation of the influence of the Swiss GDP per capita on migration flows, but also from considering if the GDP of alternative destination countries might affect Swiss immigration.

References

BSV (2015). *Statistique de l'AVS 2014 - Tableaux détaillés*. Tech. rep. BSV-318.123.15-f-tab. Office fédéral des assurances sociales, Bern. URL: https://www.bfs.admin.ch/bfs/fr/home/statistiques/securite-sociale/assurances-sociales.assetdetail.350245.html.

Bundesrat (2013). *Gesamtsicht über die Finanzierungsperspektiven der Sozialversicherungen bis 2035*. Tech. rep. Bern.

Gil-Alonso, Fernando (2012). "Ageing and Policies: Pension Systems Under Pressure". In: *The Family, the Market or the State? Intergenerational Support Under Pressure in Ageing Societies*. Ed. by Gustavo De Santis. Springer Netherlands: Dordrecht, pp. 35–58. ISBN: 978-94-007-4339-7. DOI: 10.1007/978-94-007-4339-7_2. URL: https://doi.org/10.1007/978-94-007-4339-7_2.

Han, Kyung Joon (2013). "Saving public pensions: Labor migration effects on pension systems in European countries". In: *The Social Science Journal* 50(2), pp. 152–161. ISSN: 0362-3319. DOI: 10.1016/j.soscij.2012.12.001. URL: http://www.sciencedirect.com/science/article/pii/S0362331912001292.

Liebig, Thomas and Jeffrey Mo (2013). *The fiscal impact of immigration in OECD countries; Chapter 3 in OECD (ed.) International Migration Outlook 2013 (with J. Mo)*. Chap. 3, pp. 125–190.

Milivinti, Alice and Giacomo Benini (2017). "Immigration Forecasts: a Bayesian Semiparametric Approach for Seasonal Data". Manuscript submitted for publication.

Munz, Sonja and Martin Werding (2005). "Public pensions and international migration: some clarifications and illustrative results". In: *Journal of Pension Economics and Finance* 4(2), pp. 181–207. DOI: 10.1017/S1474747205001988.

OECD (2015). "Long-term projections of public pension expenditure". In: DOI: 10.1787/pension_glance-2015-33-en. URL: https://www.oecd-ilibrary.org/docserver/pension_glance-2015-33-en.pdf.

OECD (2017). "Regional economy". In: DOI: 10.1787/6b288ab8-en. URL: https://www.oecd-ilibrary.org/content/data/6b288ab8-en.

OECD (2018). "GDP long-term forecast (indicator)". In: Accessed on 09 January 2018. DOI: 10.1787/d927bc18-en. URL: https://data.oecd.org/gdp/gdp-long-term-forecast.htm.

Razin, Assaf and Efraim Sadka (1998). *Migration and Pension*. Working Paper 6778. National Bureau of Economic Research. DOI: 10.3386/w6778. URL: http://www.nber.org/papers/w6778.

Serrano, Felipe, Begona Eguía, and Jesús Ferreiro (2011). "Public pensions' sustainability and population ageing: Is immigration the solution?" In: *International Labour Review* 150(1-2), pp. 63–79. ISSN: 1564-913X. DOI: 10.1111/j.1564-913X.2011.00105.x. URL: http://dx.doi.org/10.1111/j.1564-913X.2011.00105.x.

Sinn, Hans-Werner (1997). *The Value of Children and Immigrants in a Pay-As-You-Go Pension System: A Proposal for a Partial Transition to a Funded System*. Working Paper 6229. National Bureau of Economic Research. DOI: 10.3386/w6229. URL: http://www.nber.org/papers/w6229.

Steiner, Ilka and Philippe Wanner (2015). *Towards a New Data Set for The Analysis of Migration and Integration in Switzerland*. Working Paper 1. NCCR On the Move. URL: http://nccr-onthemove.ch/publications/towards-a-new-data-set-for-the-analysis-of-migration-and-integration-in-switzerland/.

Swiss Federal Statistical Office (2015a). *Les scénarios de lévolution de la population de la Suisse 2015 2045*. URL: https://www.bfs.admin.ch/bfs/fr/home/statistiques/population/evolution-future/scenarios-suisse.html.

Swiss Federal Statistical Office (2015b). *Scénarios de l'évolution de la population des cantons de 2015 à 2045 - Population résidante permanente des cantons selon 3 scénarios*. URL: https://www.bfs.admin.ch/bfs/fr/home/statistiques/population/evolution-future/scenarios-cantons.assetdetail.335772.html.

Swiss Federal Statistical Office (2017). *Frontaliers étrangers selon le sexe, le canton de travail et le pays de résidence*. URL: https://www.bfs.admin.ch/bfs/fr/home/statistiques/travail-remuneration/enquetes/staf.assetdetail.3722283.html.

UN Population Devision (2000). "The UN Population Division on Replacement Migration". In: *Population and Development Review* 26(2), pp. 413–417. DOI: 10.1111/j.1728-4457.2000.00413.x. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1728-4457.2000.00413.x. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1728-4457.2000.00413.x.